

## GROUNDWATER AND PUBLIC POLICY LEAFLET SERIES

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The Groundwater Policy Education Project is a joint effort of Cooperative Extension, the Freshwater Foundation, and the Soil and Water Conservation Society. These organizations joined together to create educational materials that would increase the abilities of citizens and local and state officials to make informed groundwater policy decisions.

### #5: BEST MANAGEMENT PRACTICES:IMPLICATIONS FOR GROUNDWATER PROTECTION

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Until recently, public concern for groundwater contamination centered around pathogens that could be treated effectively with disinfection. Increasingly, however, chemical contamination appears to be a more pervasive and intractable problem. How effective are agricultural best management practices at protecting groundwater from nonpoint-source pollution?

#### *BMPS: WHAT ARE THEY? WHAT CAN THEY ACCOMPLISH?*

Best management practices (BMPs) are methods, measures or practices designed to prevent or reduce pollution. They include structural and nonstructural controls as well as operation and maintenance procedures. They can be used in varying combinations to prevent or control pollution from a particular nonpoint source.

The concept of BMPs was developed specifically as a voluntary approach to addressing nonpoint-source pollution problems. When it appears that such an approach is capable of meeting desired objectives, agricultural agencies use it to address such problems as water and wind erosion. As a measure of compliance, monitoring adoption of BMPs by farmers is recognized as being far easier than monitoring edge-of-field changes in nonpoint-source pollution. Practices traditionally promoted to maintain soil productivity and increase production now serve also as BMPs to deal specifically with nonpoint-source pollution. Such BMPs as conservation tillage and tile drainage are attractive because they meet many pollution control objectives and provide economic benefits to the farmer as well.

#### *HOW CAN BMPS BE CATEGORIZED?*

Agricultural BMPs can be categorized according to environmental objective, target pollutant, environmental media affected, and management approach of the specific practice. In this regard, the word "practice" is misleading, as many BMPs are structural measures.

#### *By Environmental Objective*

Conservation practices and BMPs for specific environmental objectives include control of erosion, eutrophication, salinity, water quality improvement and proper waste management. Practices that control pollutant additions, called source controls, are effective for both surface water and groundwater control. Practices involving hydrologic modification, such as increasing infiltration to reduce surface runoff, may involve tradeoffs between protection of surface water and groundwater.

### *By Pollutant Type*

The same BMPs used for erosion control can also control, to a greater or lesser degree, surface water pollutants primarily associated with soil and sediment, including phosphorus, organic nitrogen, heavy metals, some pesticides and biological oxygen demand. The greater the association with soil or sediment, the more effective the soil erosion BMP. Conversely, such pollutants as nitrate and some pesticides and salts, which are not bound tightly to soil and sediment, are more susceptible to leaching to groundwater. These mobile pollutants require source control or treatment.

### *By Media Affected*

When considering the media affected by the pollutant, we are looking at tradeoffs between surface water and groundwater protection, or between contamination of the atmosphere and of groundwater. For example, managing soil to promote post-growing-season denitrification of nitrate may reduce nitrate leaching to groundwater, but it will increase nitrous oxide emissions to the atmosphere. Likewise, increasing water infiltration by terracing or no-till may reduce pesticide runoff at the expense of increased potential for movement to groundwater.

### *By Management Approach*

There are four general approaches to control of agricultural nonpoint-source pollutants:

1. **STRUCTURAL CONTROLS.** Structural controls, including terraces, grassed waterways, buffer strips, tile drains, irrigation systems, livestock waste storage facilities and sediment detention basins, are designed primarily to modify pollutant transport in water by reducing water use, rerouting water or retaining water. They are effective particularly for control of sediment and sediment-associated pollutants in surface runoff, but several may offer benefits for groundwater protection as well.

Structural practices are not difficult to regulate or install. They do, however, have a high capital cost, and farmer implementation generally requires cost-sharing incentives. Also, they require long-term maintenance and often are seen as a substitute for changing management approaches.

2. **SOURCE CONTROLS.** Of all management practices, source controls are the most effective and the easiest to regulate. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) can restrict specific pesticides or even ban them entirely. Expanded criteria for labeling pesticides now consider leaching potential. This new consideration, together with such specific site criteria as soil permeability and climate, can restrict pesticide use in areas vulnerable to groundwater contamination.

Nutrient application rates also can be restricted based on potential for surface water or groundwater contamination. Nutrient-loading restrictions presently are imposed for nitrogen applied to land as sewage sludge. Several states restrict application of livestock waste relative to nitrogen loading. But strict enforcement is not occurring, and there are no restrictions on chemical fertilizer application rates.

Problems with nitrogen application limits include unpredictable soil nitrogen transformations, losses that could reduce crop yields, and difficulty in administering and regulating use restrictions. More precise and timely nitrogen soil tests would strengthen the case for limiting nitrogen applications.

3. **LAND MANAGEMENT PRACTICES.** Land management practices manipulate the soil system to minimize pollutant losses in surface water or groundwater. Practices include:

- timing and placement of chemicals to achieve maximum effect and minimum carryover
- application methods for livestock waste to reduce runoff
- irrigation scheduling to minimize water use and excessive leaching, which also may reduce runoff if infiltration capacity is not exceeded
- conservation tillage for runoff and erosion control

These practices do not offer the certainty of either structural or source controls. Specific criteria for management practices are difficult to develop, and they require significant extended education efforts to

attain large-scale impact. Practices more likely to be adopted readily offer either relative ease of integration into existing farming practices or an economic or laborsaving benefit.

Monitoring of adoption rates is difficult on a large scale. There is little evidence from Rural Clean Water Program (RCWP) projects that significant implementation of management BMPs is occurring at a watershed scale. There is even less evidence for significant reductions in nonpoint-source pollution. The latter may be due to the lag time for nonpoint-source reductions caused by inherent buffering of the system against change, as well as by seasonal climate variations that can mask real trends in pollutant loadings.

Evaluation of RCWP projects suggests that one area in which reductions can be achieved is that of nutrient losses from livestock operations. Livestock waste BMPs are a combination of structural practices, including manure and washwater storage, and management practices, including rate, method and timing of manure land application.

4. *PEST MANAGEMENT PRACTICES.* Pest management practices, primarily integrated pest management practices (IPM) designed to reduce pesticide use, offer the potential for reducing pesticide groundwater contamination. Because it involves such a major departure from the prevailing approach to pest management, it has not been adopted readily by many farmers, despite extensive educational programs in the 1970s and 1980s.

#### *HOW EFFECTIVE ARE BMPS?*

The effectiveness of BMPs can be rated in terms of their impact on pollutant loads, acceptability by farmers, cost-effectiveness, and ease of implementation and maintenance. An effective BMP also has minimum negative impact or tradeoffs. Clearly, source controls for the most part meet all of these criteria, and, for intractable pollutants, total ban is the only solution. But this approach can be applied only when there are such suitable alternatives as substitute compounds.

Source reductions also are effective if the degree of reduction is large enough to have an impact on pollutant loadings. For example, reducing land application of manure from 20-30 tons per acre per year down to 5-10 tons per acre per year will have a significant impact on nitrate leaching. Reducing nitrogen fertilizer use by 10 percent will have much less effect. Source control is also most effective when the potential for transport to surface water or groundwater is high. Back-siphoning in chemigation systems, discharge of pesticide rinsewater directly to streams or in the vicinity of wells, and direct runoff of manure all produce very high local concentrations of pollutants that require source control for optimum management.

BMPs that reduce transport of pollutants to surface water or groundwater are less effective than source controls. The impact of BMPs is dictated by variability in local climatic and hydrologic conditions. Because these impacts are not easy to account for, it is difficult to reduce leaching of groundwater contaminants.

#### *HOW EFFECTIVELY DO BMPS PROTECT GROUNDWATER?*

##### *Protection from Nitrate*

The degree of implementation of a particular practice will determine its overall effectiveness. For nitrate, the most effective approach is restricting application rate to coincide with crop requirements. This is particularly true for crops with high nitrogen fertilizer requirements, for land application of livestock wastes, and for irrigation water management. The difficulty is in establishing nitrate rate limits that protect the farmer against both seasonal variations in a crop's nitrogen use efficiency and such nonleaching losses as denitrification. More efficient nitrogen-use practices, such as split applications, have not been accepted widely by farmers because of both greater time and management required as well as risk of crop yield reductions with these practices.

In areas where concentrated livestock operations result in excessive manure applications, applying a strict nitrogen application rate limit to lands receiving livestock waste would have a significant impact on nitrate levels in local groundwater. Monitoring of day-to-day manure application is not feasible, but requiring manure management plans for an entire livestock operation is reasonable if the land base is adequate for application at nitrogen crop utilization rates.

### *Protection from Pesticides*

Pesticide contamination of groundwater is both compound specific and site specific, suggesting that the problem is not so widespread as that of nitrate contamination. It also offers insights for its control. FIFRA provisions, which currently include leachability of the compound, could be expanded to include label restrictions based on site- or region-specific soil, bedrock and climatic conditions favoring pesticide movement to groundwater. This is essentially the approach employed by California.

The U.S. Environmental Protection Agency's (EPA's) Wellhead Protection Program, which establishes statutory requirements for state wellhead protection programs, is an effective approach to protecting public water supply wells and could be expanded over time to include private wells. Implementing wellhead protection measures will require applicator training under FIFRA and Extension education programs, but these are measures that farmers likely will accept. Such measures as sprayer calibration and better rinsing and disposal of pesticide containers can be effective in protecting individual wells.

There is significant potential for IPM to decrease pesticide use and, therefore, the risk of groundwater contamination. Because IPM comprises a broad set of practices, quantifying its adoption can be difficult. It appears, however, that the full range of IPM practices has had only limited farmer acceptance. IPM requires considerable time and greater management skills, and it may be perceived as riskier than prophylactic or calendar-scheduled pesticide use. Unless mandated by law, or unless Extension and research priorities shift more dramatically in favor of IPM, it is unlikely to have much impact on future pesticide use.

### *WHAT FACTORS AFFECT IMPLEMENTATION OF BMPS?*

#### *Farm-Level Factors*

With the exception of conservation tillage (but not no-till practices), farmers generally have not adopted BMPs except in special projects or where high levels of cost-sharing and technical assistance were available.

This is a result of either the inability or the unwillingness of implementation agencies to direct BMPs for maximum impact in an effective manner. Agencies have been unable to concentrate resources on a few farms and are more likely to widen the criteria for site selection to make cost-sharing available to most farmers willing to participate. This diffusion of effort results in lower effective control of pollutants and makes it difficult to monitor effects even when they are likely to occur.

Evaluation of RCWP projects suggests that the most effective BMPs are those that the farmer is likely to maintain after cost-sharing is terminated. This is an essential consideration since nonpoint-source pollutant levels in a watershed are strongly buffered by natural watershed processes. For such sediment-associated pollutants as phosphorus or DDT, response time is on the order of a decade after significant implementation of BMPs, which suggests that they must be maintained for at least that long.

Directing BMPs and funding for such implementation procedures as cost-sharing, technical assistance and education are critical to maximum impact in most agricultural nonpoint-source pollution abatement projects. This factor recognizes the reality that sufficient resources likely will never be available to treat all sources of pollution.

Efficient allocation of surface water and groundwater protection funds is made even more difficult by lack of water quality criteria in selecting treatment areas. Soil Conservation Service (SCS) and state conservation agencies have relied heavily on soil erosion rates and the concept of soil loss tolerance to target many land treatment practices. These, however, may not correlate with particular water quality problems.

Watershed computer simulation models, such as ANSWERS, offer an effective means of identifying critical areas of surface water nonpoint-source pollution. Groundwater models provide similar capabilities for identifying critical areas for groundwater protection. Once identified, these areas can receive intensive, long-term treatment, resulting in easier monitoring of BMP adoption.

#### *Institutional Factors*

Along with implementation constraints at the farm level, a number of institutional issues can affect implementation of groundwater protection programs based on agricultural BMPs:

- Most existing agricultural nonpoint-source programs are administered by states. The federal government has provided planning funds through the Clean Water Act, but only limited implementation funds have been appropriated for other than specific demonstration projects.
- State nonpoint-source plans and demonstration projects have had little or no groundwater protection focus.
- Until recently, there have been no specific groundwater protection programs in USDA Extension, research or conservation agencies. While newly developed groundwater policies now commit federal agency resources to nationwide programs in groundwater protection, the declining real-dollar budgets of these agencies may minimize the impact of these efforts.

#### *WHAT ARE THE STRENGTHS AND WEAKNESSES OF THE BMP APPROACH?*

Developed by environmental and agricultural agencies, the BMP approach is a means of addressing nonpoint-source problems in a manner compatible with the traditional, voluntary approach to resource management - an approach that has failed to produce significant national reductions in nonpoint-source pollution.

Environmental pollution has been a major issue not of the agricultural community but rather of environmental groups with a generally urban base. It should not be surprising, then, that BMPs have not been accepted widely by the agricultural community, particularly in the absence of cost-sharing or a clear economic advantage for the practice.

Resources must be directed to problem areas where BMPs will have the greatest long-term impact. Farmers must be motivated through education, technical assistance, cost-sharing when necessary, and some regulatory sanctions to address agricultural pollution problems. Farmers' concerns for groundwater protection will be greater than for surface water because farm families are worried about contamination of their own wells. Education programs should focus on this critical factor.

There are a number of benefits to voluntary adoption of BMPs. They are more acceptable to farmers, they offer more flexibility for site-specific conditions and farmers' abilities to adopt them, and they do not require the level of enforcement of a strictly regulatory approach. The farming community has argued that, for agriculture, the voluntary approach is more appropriate than regulations. Unlike less competitive industries, farmers generally are less able to pass on to consumers the increased production costs incurred due to pollution abatement. Since regulatory policies are differentially applied in individual states or local areas, and since farmers from such various areas may compete in the same market, those in more heavily regulated areas may have to incur the economic hardship of absorbing increased costs.

Furthermore, application of a regulatory approach to nonpoint-source pollution problems has the significant problem of identifying both measurable, enforceable water quality standards and the resources needed to monitor compliance on millions of acres of agricultural land. Yet, despite the appeal of the BMP approach to nonpoint-source agricultural pollution abatement, the lack of significant adoption of these practices in the 15 years since they were proposed suggests that other measures must be considered if water quality benefits are to be realized.

#### *WHAT ARE SOME ALTERNATIVE METHODS OF PROTECTING GROUNDWATER FROM AGRICHEMICALS?*

##### *Conservation Plans*

The 1985 Food Security Act requires that farmers receiving support payments have a fully implemented conservation plan in place by 1995. Little groundwater protection will result from this program for many reasons:

- There are no water quality provisions in the cross-compliance measure, and certainly none for groundwater protection.
- The resources of SCS and state agencies will be stretched thin in trying to meet the deadlines mandated in the act.
- There are insufficient federal and state resources to monitor compliance.

- Because there is little or no directing of resources in the cross-compliance section of the act, any benefits in sensitive groundwater contamination areas will be much less than if efforts were differentially allocated.

SCS has used farm-level conservation planning for decades in helping farmers address erosion problems. The approach has been strictly voluntary, the agency has taken the generally passive role of responding when requested, and the goal has been maintenance of onfarm soil productivity. Off-site water quality has not been a primary issue to date. SCS recently has begun to update its technical guides and to train state technicians to incorporate water quality goals into conservation planning. While the intent is to ensure that conservation planning is consistent with general water quality goals, specific practices for nutrient or pesticide management are not required. Nevertheless, this is an important step by the primary field-level technical assistance agency in most states.

#### *Low-Input Sustainable Agriculture Systems*

As a result of agricultural environmental problems and downturns in the U.S. farm economy, there has been a growing questioning of the entire U.S. agricultural production system. There are those who maintain that U.S. agriculture is too production oriented and nonresponsive to environmental problems. Organic farmers and others argue for "low-input" or "regenerative" farming systems that minimize the use of synthetic fertilizers and pesticides. An important tenet of these systems is that the primary goal should not be absolute production but rather a system that results in minimal environmental disturbance.

In terms of groundwater protection, substitution of biological and cultural pest control for pesticides would eliminate pesticide groundwater contamination. These systems may not reduce nitrate contamination of groundwater, however, unless nitrogen is managed properly. The problems of excessive manure application will continue to exist even when a farmer uses no chemical fertilizer.

The debate over sustainable agriculture is healthy, as it forces agriculture to question its basic premises. It is unlikely, however, that there will be more than a modest movement in this direction by U.S. farmers in the next decade. Unless forced by environmental regulation or other inducements, few present-day farmers will perceive sufficient benefits from low-input systems to warrant the changes involved.

#### *CONCLUSIONS*

An examination of existing approaches to nonpoint-source water pollution abatement reveals several facts:

- Nonpoint-source abatement programs have never been funded at a level that would allow sufficient implementation to evaluate their chances for success.
- Nonpoint-source demonstration projects indicate that, even when significant resources can be brought to bear, they are not sufficient to be effective.
- Most existing BMPs are designed for erosion control and livestock waste storage and handling. Few directly address either surface water or groundwater quality.
- Measures that control the source of pollution are likely to be most effective in terms of implementation and degree of control. Such source controls are preferable to adoption of BMPs, which usually demonstrate only marginal success at reducing nonpoint-source pollution.
- Pesticide regulation under FIFRA and the new Wellhead Protection Program are good examples of source control.
- The most important local source of nitrate groundwater contamination is live stock waste disposal, which should be targeted for control.
- BMPs directed to manure storage and handling will not solve problems of disposal of excess manure nitrogen on limited crop and pasture land.
- Groundwater protection programs and surface water protection programs should not be separated from each other.

- Long-term monitoring, over years or even decades, is needed to determine accurately the effectiveness of BMPs at a realistic field scale.

While agricultural best management practices have the potential to provide protection of groundwater from agrichemicals, their effectiveness is limited by both on-farm and institutional factors. These factors must be recognized and addressed if BMPs are to become an effective approach to addressing nonpoint-source pollution.

The unedited version of the paper on which this leaflet is based appears in the March-April 1990 issue (Volume 45, Number 2) of the Journal of Soil and Water Conservation. This special issue, titled "Rural Groundwater Quality Management: Emerging Issues and Public Policies for the 1990s," may be ordered from the Soil and Water Conservation Society, 7515 N.E. Ankeny Road, Ankeny, Iowa 50021-9764, for \$12.

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The assistance of Gaynell Meij, David Patte and Mike Hattery is gratefully acknowledged.

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